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Status of Atlantic Salmon (*Salmo salar* L.) Populations in Crabbes and Robinsons Rivers, and Middle Barachois, Fischells and Flat Bay Brooks, Newfoundland, 1999

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Abstract

Adult Atlantic salmon were counted visually in Crabbes River, Middle Barachois Brook, Robinsons River, Fischells Brook, and Flat bay Brook, 23-29 August 1999. The surveys were conducted by crews of 3 to 12 snorkellers floating down the main stem of each river. Water levels were moderately low and salmon were predominately concentrated in pools with water depths less than 1m. An adjustment factor, ranging from 1.0 to 1.5 was applied to the counts in each river section to account for fish not observed in the larger pools. There were no known removals after the survey, therefore the adjusted count is considered to be the spawning escapement for the river. There were no retention angling fisheries on these rivers in 1999. An assumed mortality of 10% was applied to the estimates of the numbers of salmon that were hooked-and-released. The estimated total numbers of salmon that returned to each river are: Crabbes River, 686 small and 264 large salmon; Middle Barachois Brook, 559 small and 67 large salmon; Robinsons River, 1431 small and 203 large salmon; Fischells Brook, 1264 small and 246 large salmon: and, Flat Bay Brook, 2261 small and 235 large salmon. The percentage of the egg deposition conservation requirements achieved were 65% for Crabbes River, 44% for Middle Barachois Brook, 117% for Robinsons River, 110% for Fischells Brook, and 149% for Flat Bay Brook. The egg deposition is higher in 1999 than in 1998 for all rivers except Middle Barachois Brook. The apparent low egg deposition in Crabbes River and Middle Barachois Brook may be related to the unusually severe flood that occurred in February 1996, which may have caused high juvenile mortalities. The information available did not lend itself to forecasting the abundance of salmon in 2000. Two rainbow trout were observed in Robinsons River and Flat Bay Brook. Their origin is unknown.

Résumé

Du 23 au 29 août 1999, des dénombrements visuels des saumons atlantiques dans les rivières Crabbes et Robinsons, ainsi que dans les ruisseaux Middle Barachois, Fischells et Flat Bay, ont été effectués par des équipes de 3 à 12 plongeurs en apnée qui se laissaient flotter dans le cours principal de chaque rivière. Les niveaux d'eau étaient modérément bas, et les saumons se concentraient surtout dans les fosses de profondeur inférieure à un mètre. Le nombre de saumons observés dans chaque tronçon a été corrigé par un facteur variant entre 1,0 et 1,5 pour tenir compte des poissons qui n'ont pas été aperçus dans les plus grandes fosses. Comme il n'y a eu aucun prélèvement connu de poissons après le relevé, les dénombrements corrigés sont considérés comme représentatifs de l'échappée des géniteurs. Aucune pêche à la ligne avec conservation des captures n'a été pratiquée dans ces cours d'eau en 1999. On a appliqué une mortalité présumée de 10 % aux estimations du nombre de saumons capturés puis remis à l'eau. Voici les estimations de la remonte totale dans chaque cours d'eau : 686 petits et 264 grands saumons dans la rivière Crabbes; 559 petits et 67 grands saumons dans le ruisseau Middle Barachois; 1431 petits et 203 grands saumons dans la rivière Robinsons; 1264 petits et 246 grands saumons dans le ruisseau Fischells; 2261 petits et 235 grands saumons dans le ruisseau Flat Bay. Les pourcentages de la ponte nécessaire à la conservation atteints dans chaque cours d'eau sont les suivants : 65 % dans la rivière Crabbes, 44 % dans le ruisseau Middle Barachois, 117 % dans la rivière Robinsons, 110 % dans le ruisseau Fischells et 149 % dans le ruisseau Flat Bay. Dans tous les cours d'eau excepté le ruisseau Middle Barachois, la ponte a été plus élevée en 1999 qu'en 1998. La faible ponte apparente dans la rivière Crabbes et le ruisseau Middle Barachois pourrait être liée à la crue anormalement forte de février 1996, qui aurait entraîné une forte mortalité des juvéniles. Les données disponibles ne se prêtaient pas à la prédiction de l'abondance du saumon en 2000. Deux truites arc-en-ciel d'origine inconnue ont été observées dans la rivière Robinsons et le ruisseau Flat Bay.

Introduction

Atlantic salmon populations in Bay St. George rivers declined in the 1970's (Porter and Chadwick 1983) and have been below conservation levels for most of the past 30 years (Reddin and Mullins, 1996). The total returns to rivers appear to have only marginally increased with the closure of the commercial fisheries in 1992. Direct measurements of salmon population sizes in most rivers are difficult to obtain using conventional fish counting facilities due to the large size of the rivers and their extreme range in discharge.

Reddin and Mullins (1996) conducted assessments of the salmon populations in rivers in Bay St. George, used angling catch statistics and estimates of angling exploitation rates to estimate population sizes. Snorkelling surveys have been used to estimate the numbers of large and small salmon spawners in several rivers in Bay St. George since 1996 (Bourgeois et al. 1997), (Porter 1997 and 1999), and (Porter and Bourgeois 1998). These surveys indicated generally higher populations of salmon in recent years than in late 1980's and early 1990's. An exception was Fischells Brook, which appeared to have a low population size in 1998.

Snorkelling surveys were again conducted in 1999, to obtain estimates of small and large salmon in Crabbes and Robinsons rivers, and Middle Barachois, Fischells and Flat Bay brooks (Figs 1-5). This document is an assessment of the status of the salmon populations in these rivers. The physical characteristics of five rivers are described in Table 1.

Fisheries Management Measures

In 1978, restrictions were placed on the commercial and recreational fisheries in response to a decline in returns of salmon to Bay St. George rivers (Chadwick et al 1978). Further reductions were placed on the commercial fisheries in the 1980's, and it was eventually closed in 1992. The retention of large salmon has been prohibited since1984. The changes in season and quotas in the recreational fisheries since 1953 are shown in Table 2. In 1992 and 1993 there were Salmon Fishing Area (SFA) quotas for the recreational fisheries, but the quota for SFA 13, which includes Bay St. George) was only reached in 1992. Flat Bay Brook was closed to all angling in 1995 and 1996, and Fischells Brook was closed in 1999. Due to high water temperatures and low water levels in 1999, Crabbes River and Middle Barachois Brook were closed to angling 25 June - 28 July and 5-9 August; Robinsons River was closed 25 June - 15 July, and 21-28 July; and Flat Bay Brook was closed 25-29 June.

Methods

Recreational Fisheries data

Angling data were available from the salmon angler licence stub in 1999 (see O'Connell *et al.*1998 for a description of the methodology).

Unrecorded mortalities

An estimate of all fish killed or naturally died before spawning is important for any stock assessment. Illegal activities do occur on the rivers being assessed; however, no quantitative estimates of salmon mortality are available. The percentage of the released salmon that will die will vary with handling techniques and water temperature (Anon 1998) (Willie et al., 1996; and Broil et al, 1996). Mortality of hooked-and-released salmon at water temperatures below 20° C is believed to be less than 10%. This value was applied to the estimated number of salmon released for the five rivers assessed.

Biological characteristics

The biological characteristics that are most important for assessing the status of an Atlantic salmon population are: proportion of large (≥ 63 cm) and small (<63) salmon, mean weight or length and percent female of each size group, and relative fecundity. The values of these parameters determine the reproductive potential of the stock.

For Crabbes and Robinsons rivers and Fischells Brook, the mean weights (1.63 kg for small, 5.06 kg for large) and percentage female (71.9% for small, 86.8% for large salmon) used in this assessment are values for years 1992-94 from Table 6a & b in Reddin & Mullins (1996) (Table 3). The mean weight, mean length and percent female for the salmon population in Middle Barachois Brook are those obtained from 34 large salmon and 71 small salmon seined in Section 1, Middle Barachois Brook, in August, 1997. The estimated mean fecundity of 1540 eggs/kg of body weight used by Porter & Chadwick (1983) was also used for Crabbes and Robinsons rivers, and Fischells and Middle Barachois brooks. The percentage of large and small salmon in each population used in this assessment is the percentage observed in the survey in 1999.

For Flat Bay Brook, biological characteristics data were available for fish taken as broodstock in 1994-96 and from the angling fishery in 1994 (Table 3) (Bourgeois et al. 1997). These values were used in this assessment except for percent female for small salmon, which was taken from Reddin and Mullins (1996). A length -fecundity relationship, for Flat Bay Brook, was developed from samples taken as broodstock in 1995 and 1996 (Porter and Bourgeois 1998).

Conservation spawning requirements

Spawning requirements for Atlantic salmon represent an estimate of the number of eggs (or spawners) required for conservation of the stock (O'Connell & Dempson 1995). Juvenile salmon rear in both fluvial and lacustrine habitat and thus spawning requirements are based on the number of eggs required for both types of habitat (O'Connell & Dempson 1995). The habitat accessible to sea-run salmon in Crabbes and Robinsons rivers, and Middle Barachois, Fischells and Flat Bay brooks is primarily fluvial with little lacustrine habitat (Table 1). Therefore, in relation to the fluvial habitat, the production of parr in lacustrine habitat would be small but still important.

Conservation egg deposition requirements for the five rivers being assessed are those calculated by Reddin & Mullins (1996) as target eggs.

The conservation requirements in terms of numbers of spawners requires knowledge of the portion of the eggs which should come from both large salmon and small salmon. Since these rivers are believed to historically have had a significant component of virgin 2SW salmon it is uncertain how to determine the appropriate number of large salmon that should be in the spawning population to meet its conservation requirements. Since the populations are currently at low levels the observed proportions may not be the appropriate composition for conservation of the large salmon component. Estimate of the large and small salmon conservation requirements were calculated by Porter and Bourgeois (1998) but were not recommended for use as minimum threshold limits for fisheries management due to the above mentioned uncertainties.

Number of Spawners and Total Returns to Rivers

Atlantic salmon were visually counted in Crabbes and Robinsons rivers, and Middle Barachois, Fischells and Flat Bay brooks between 23 August and 29 August 1998, by surveyors who snorkelled down that portion of the main stem, of each river, accessible to anadromous salmon. The only tributaries surveyed were Little Crabbes Brook (Crabbes River) and Northern Feeder (Robinsons River). The tributaries in each of the rivers are small and generally had low water levels. Few salmon were observed in the tributaries during surveys in previous years. Water levels in 1999 were moderately low during the survey, however there was a heavy rain during the night of 29 August, which prevented surveying Section 5 of Crabbes River and Flat Bay Brook.

The main stem of each river was divided into four or five sections with each section normally being less than 10 km in length (Figs 1, 2, 3, 4, and 5). There were four main differences between the procedures used in conducting the survey in1999 from that reported by Porter (1999) and Porter and Bourgeois (1998). These were: 1) a general increase in the number of snorkellers in each crew; 2) a portion of Fischells Brook, called "the Steadies", which was not surveyed in 1998, was surveyed in 1999; 3) there were some changes to some Section boundaries; 4) a helicopter was used to ferry the survey crew between pools in Sections 1 and 2 of Flat Bay Brook. These two Sections contain only a few pools, and in previous years, very few salmon were observed outside these pools.

A survey crew, comprising of snorkellers and recorders, was assigned to each river Section. Crews varied in size from 3 to 16 people, with a minimum of three and a maximum of 12 snorkellers per crew. The snorkellers would passively float or swim downstream and count salmon; and, one or two recorders would walk along the riverbank and record the information. A rope was frequently stretched across the river and held in place by two recorders; the snorkellers would line up across the river along the rope such that there was total underwater horizontal visual coverage. The recorders would slowly walk down river with the snorkellers holding onto the rope. The snorkellers would all look underwater in the same direction across the river and count the salmon that passed between himself/herself and the adjacent surveyor. This technique proved to be very effective and greatly increased the confidence in the estimates of the number of fish in the larger

pools. Water depths in most riffle areas were frequently too low shallow for swimming, particularly in the upper sections (Sections 1 and 2) of each river.

Information collected included: numbers of large and small salmon, number of salmon with net marks or other injuries, and a description of the pools where salmon were observed. Pools were numbered on a map and crossed referenced to a field notebook. If snorkellers were unsure of the count, they would float through the pool a second or third time. When two or more passes were made through the same pool the highest count was recorded, except in circumstances where the numbers of fish were estimated, then an average was recorded.

There was no calibration of possible differences between teams or individuals. There are many factors that affect accuracy and precision of the counts by individuals and collectively by the teams. These factors include water depth and width of pools, turbidity and colour of water, angle of sun, and light conditions in general.

Some of pools were too deep or large to obtain a complete count of salmon. Therefore, an adjustment factor was applied to the count in each section to account for unobserved salmon. This factor was determined subjectively in consultation with the snorkellers, taking into consideration the number and size of the pools in which complete counts could not be ascertained, and the number of salmon counted in adjacent pools.

The numbers of salmon in Section 5 in Crabbes River and Flat Bay Brook were estimated by using the average proportion of the total population of salmon in Section 5 of each river in 1996 and 1997, as reported in Bourgeois et al. (1997), Porter (1997) and Porter and Bourgeois (1998).

The adjusted numbers of large and small salmon are believed to represent the total numbers in each river at the time of the survey. It is assumed that these numbers approximate the spawning escapement, since no information is available on mortalities after the survey, and it is believed that the majority of spawners have entered the river prior to the survey.

The total returns to each river was obtained by adding 10% of the number of salmon hooked-and-released to the estimated spawning escapement. No adjustment was made for illegal removals, since there are no reliable estimates available.

Egg deposition

The unadjusted and adjusted egg deposition (ED_{ua} & ED_a) for Crabbes River, Middle Barachois Brook, Robinsons River, and Fischells Brook, in 1999, were calculated for small and large salmon separately then summed as follows:

(3) $$ED_{ua} = (UN_S * PF_S * RF_S * MW_S) + (UN_L * PF_L * RF_L * MW_L)$$

(4) $$ED_a = (AN_s * PF_S * RF_S * MW_S) + (AN_L * PF_L * RF_L * MW_L)$$

Where: $UN_{S \text{ or } L}$ = unadjusted numbers of small or large salmon counted in the survey
$PF_{S \text{ or } L}$ = percent female small or large salmon
$RF_{S \text{ or } L}$ = relative fecundity for small or large salmon (1540 eggs/kg)
$MW_{S \text{ or } L}$ = mean weight for small or large salmon
$AN_{S \text{ or } L}$ = adjusted number of small or large salmon counted in the survey

The unadjusted and adjusted egg deposition (ED_{un} & ED_a) for Flat Bay Brook, in 1999, were calculated for small and large salmon separately then summed as follows:

(5) $$ED_{un} = (UN_S * PF_S * F_{FS}) + (UN_L * PF_L * F_{FL})$$

(6) $$ED_a = (AN_s * PF_S * F_{FS}) + (AN_L * PF_L * F_{FL})$$

Where: $F_{FS \text{ or } FL}$ = fecundity of small or large salmon for Flat Bay Brook based on length/fecundity relationship, y = 173.02x - 6266.8 (Porter and Bourgeois 1998).

Percentage of Conservation Level Achieved

The adjusted and unadjusted percentage of the conservation egg deposition levels achieved in each river in 1999 were calculated as follows:

(3) Percentage of conservation level achieved = $(ED_{un \text{ or } a} / CED) * 100$

Where: CED = egg deposition required for Conservation

The percentage of the conservation egg deposition level achieved in Middle Barachois Brook in 1996 and 1997 was recalculated using the biological characteristics collected in 1998.

Results

Recreational Fisheries Data

The angling catch statistics for 1999 for the Crabbes River, Middle Barachois Brook, Robinsons River, Flat Bay Brook, as compiled from the angling licence stub returns, are provided in Table 4. Fischells Brook was closed to all angling. The catch rate for hook-and-released small salmon ranged from 4.2% on Crabbes River to 22.3% on Robinsons River (Table 4). The catch rate for large salmon ranged from 4.6% on Crabbes River to 18.2% on Robinsons River. The catch statistics from 1974-99 are also provided in Appendices 1-5. It should be noted that the angling

data collected prior to 1996 were collected by Fisheries Guardians and/or River Monitors and may not be directly comparable to the data derived from the licence stub returns.

An estimate of the angling effort is not available for 1996-99, since many anglers did not properly record this information on their license return. The numbers of small and large salmon estimated to have been hooked-and-released, in 1999, on Crabbes and Robinsons rivers were the lowest since 1995. On Barachois Brook the number of small salmon hooked-and-released was higher than in 1998, but lower than in 1997. The numbers of large salmon caught is the lowest since 1991. On Flat Bay Brook, the catch of small salmon was higher, in 1999, than in 1998, but slightly lower than in 1997; whereas, the catch of large salmon was lower than in either 1998 or 1997.

Unrecorded Mortalities

The estimated angling mortality ranged from three (3) small salmon Crabbes River to 32 small salmon on Robinsons River. For large salmon, the mortality was one (1) fish on Crabbes River and Middle Barachois Brook to four (4) fish on Robinsons River and Flat Bay Brook (Table 4).

Biological Characteristics

The parameter values for mean weights, mean lengths, and percent female and percentage small and large salmon used to calculate the total egg deposition in each river is provided in Table 3. The percentage of large salmon in the each spawning population, in 1999, is shown in Tables 5 to 9. The length-fecundity relationship developed for Flat Bay Brook is $y = 173.02x - 6266.8$ (Porter and Bourgeois 1998). A summary of the biological characteristics (length, weight, sex, age) of the salmon from Middle Barachois Brook sampled in 1998 is provided in Appendix 6. It is interesting to note that 26.7% of the virgin 2 SW salmon are < 63 cm and 100% of the 2 SW salmon were females. About 86% of the virgin 1 SW salmon and 93% of the virgin 2 SW salmon were river age 3.

Conservation Spawning Requirements

The number of eggs required for conservation in each river is provided in Table 1 and shown below:

Crabbes River	4,600,000 eggs
Middle Barachois Brook	2,100,000 eggs
Robinsons River	3,300,000 eggs
Fischells River	3,600,000 eggs
Flat Bay Brook	3,800,000 eggs

Number of Spawners and Total Returns to Rivers

Salmon were highly concentrated in a small number of pools in each river. Very few salmon were found in riffles or in pools less than one meter in depth. Densities greater than 10 salmon were found in 20 pools in Crabbes River, 13 pools on Middle Barachois Brook, 22 pools in Robinsons River, 23 pools in Fischells Brook, and 21 pools on Flat Bay Brook. The unadjusted and the adjusted numbers of small and large salmon counted in Crabbes River, Middle Barachois Brook, Robinsons River, Fischells Brook, and Flat Bay Brook are provided in Tables 5 to 9 respectively. The adjustment factor applied to the actual counts in different river sections ranged from 1.0 to 1.5 (Tables 5-9). The overall adjustment factor for the count in each river ranged from 1.12 for Fischells Brook to 1.31 for Crabbes River. The rationale for choosing each adjustment factor is provided in Appendix 7. The adjusted counts of small and large salmon are assumed to be the number of spawners since there were no known removals subsequent to the survey. A summary of the estimated spawning escapements to these five rivers, 1953-99 is provided in Table 10.

Crabbes River

The greatest numbers of small and large salmon in Crabbes River were found in Section 2, although pools with relatively high numbers were also found in Sections 1 and 3 (Table 5). The highest percentage (39%) of large salmon was found in Section 4. River Guardians surveyed Little Crabbes Brook, tributary of Crabbes River, and counted 17 small and four (4) large salmon. No adjustment was made to the count on Little Crabbes Brook. The lower 1-km of two other tributaries in Section 2 was surveyed, with less than 5 salmon counted in each. These observations were included in the counts for Section 2.

The total number of spawners estimated to be in Crabbes River in 1999 is 946 salmon, of which 683 (72.2%) are small and 263 (27.8%) are large salmon (Table 5). The spawning escapement of small salmon in 1999 is the third highest estimate since 1984. This escapement, although higher (42%) than in 1998, was 16% below the 1996-98 mean (Table 10). The spawning escapement of large salmon in 1999 was 54% higher than in 1998, 24% lower than in 1997; and about the same as the 1996-98 mean. The total returns of small and large salmon to Crabbes River, 1953-1999, are provided in Table 11.

Middle Barachois Brook

Ninety-four percent of the small salmon and 82% of the large salmon, in Middle Barachois Brook, were found in Sections 1 and 2 (Table 6). No tributaries were surveyed in 1999.

The total number of spawners in Middle Barachois Brook in 1999 is estimated to be 621 salmon, of which 556 (89.4%) are small salmon and 66 (10.6%) are large salmon (Table 6). The spawning escapement of small Atlantic salmon in 1999 was 47% lower than in 1997 (there was no estimates for 1998), but 40% lower than the 1996-97 mean (Table 10). The spawning escapement of large salmon was 64% lower than in 1997 and 39% lower than the 1996-97 mean.

The total returns of small and large salmon to Middle Barachois Brook, 1953-1999, are provided in Table 11.

Robinsons River

In Robinsons River, 86% of the small and 89% of the large salmon were located in Sections 1 and 2. The River Guardians surveyed Northern Feeder, Section 4, by walking along the riverbank, but no salmon were observed.

The total number of spawners in 1999 is estimated to be 1599 salmon, of which 1399 (87.5%) are small salmon and 199 (12.5%) are large salmon (Table 7). The spawning escapement of small salmon in 1999 was 38% higher than in 1997 (there was no estimates for 1998), and 57% higher than the 1996-97 mean (Table 10). The spawning escapement of large salmon was 16% higher than in 1997, and 36% higher than the 1996-97 mean. The total returns of small and large salmon to Robinsons River, 1953-1999, are provided in Table 11.

Two rainbow trout were observed in Section 4 of Robinsons River. Both were estimated to be between 30-40 cm and in length.

Fischells Brook

In Fischells Brook, 71% of the small and 82% of the large salmon were found in Sections 1 and 2. No tributaries were surveyed in 1999.

The total number of spawners in 1999 is estimated to be 1509 salmon, of which 1264 (83.7%) are small salmon and 246 (16.3%) are large salmon (Table 8). Spawning Escapement of small salmon in 1999 was 552% higher than in 1998 and 111% higher than in 1997 (Table 10). The spawning escapement of large salmon was 242% higher in 1999 than in 1998 and 237% higher than in 1997. The total returns of small and large salmon to Fischells Brook, 1953-1999, are provided in Table 11.

Flat Bay Brook

In Flat Bay Brook, 56% of the small and 49% of the large salmon were located in Section 4. No tributaries were surveyed.

The total number of spawners in 1999 is estimated to be 2468 salmon, of which 2237 (90.6%) are small salmon and 231 (9.4%) are large salmon (Table 9). The spawning escapement of small salmon in 1999 was 74% higher than in 1997, (there is no estimate for 1998) and 92% higher than the 1996-97 mean (Table 10). The spawning escapement of large salmon was 38% higher than in 1998, and 65% higher than the 1996-97 mean. The total returns of small and large salmon to Flat Bay Brook, 1953-1999, are provided in Table 11.

Two rainbow trout were observed in Section 4 of Flat Bay Brook. One was estimated to be about 25 cm and the other 30-40 cm in length.

Egg Deposition

The estimated egg deposition and percentage of conservation level achieved in 1999 are provided in Table 12, and summarized below. Estimates of the percentage of the conservation egg deposition levels achieved in each of the five rivers, 1953-99, are provided in Table 13 and Figures 6 and 7.

River	Egg Deposition	% Conservation achieved
Crabbes River	$3.0*10^6$	65
Middle Barachois Brook	$0.9*10^6$	44
Robinsons River	$3.9*10^6$	117
Fischells Brook	$3.9*10^6$	110
Flat Bay Brook	$5.6*10^6$	149

The revised calculations of the egg deposition in Middle Barachois Brook in 1996 and 1997 resulted in a reduction in the previous estimates of percent conservation level achieved from 81% to 52% in 1996, and from 148% to 95% in 1997.

Net Marked Salmon

The numbers of salmon observed with external marks, including net marks and other injuries and percent of total number of fish observed, 1997-99 are as follows:

River	1997	1998	1999
Crabbes River	13 (1.1%)	13 (3.2)	10 (1.4%)
M. Barachois Brook	9 (0.8%	N/A	10 (1.8%)
Robinsons River	22 (2.1%)	N/A	5 (0.4%)
Fischells Brook	10 (1.7%)	2 (0.9%)	5 (0.4%)
Flat Bay Brook	17 (1.3%)	N/A	12 (0.6%)

Discussion

The procedures for conducting the snorkeling surveys continue to improve, with the addition of more snorkellers in the larger pools, and a refinement of the field logistics. These improvements, as well as the increase in experience of the surveyors should have resulted in better estimates of population sizes in 1999 than in previous years. There are still several pools where the technique needs to be modified. One of these is the km-long gorge on Crabbes River. An exploratory survey of three pools in the gorge indicated that there may not have been a large number of salmon in the gorge in 1999, and that it may be possible to survey a larger portion of the gorge in future years. There are still several pools in each river that are too deep to see the bottom and all techniques tried were unsuccessful. However, observations of salmon in pools in which the bottom can be seen, indicate that in the deeper pools, salmon are not generally in the deeper water, but rather in parts of pools that are <3m in depth. Section 5 of both Crabbes River and Flat Bay Brook could not be surveyed due to high discharge. Estimates of the number of salmon in these sections were calculated by using the average proportion of the total population of salmon estimated to be in these sections in previous years. The calculated proportions are: 0.045 for small and 0.023 for large salmon in Crabbes River, and 0.16 for small and 0.38 for large salmon in Flat Bay Brook. There is some evidence that these proportions are reasonable. Although water conditions, in 1999, were high, snorkellers did float down Section 5 of Crabbes River and about 1 km of Flat Bay Brook. No salmon were seen in Section 5 of Crabbes River; whereas, 38 small and 2 large salmon were counted in the 1 km of Section 5 of Flat Bay Brook.

Survey bias by anglers, both in counting large numbers of fish and sizing the fish, needs to be examined verified. This bias is difficult to determine due to differences in water conditions throughout a river and between rivers. Bias could be related to individual angler differences that may vary with the distance from fish, peripheral vision, attention span, turbidity of water, angle of the sun, and light conditions. An attempt will be made in subsequent surveys to measure some differences among snorkellers by using model fish.

The spawning escapements of small and large Atlantic salmon improved in Crabbes River relative to 1998, although they were lower than estimated for 1997 (Table 10). However, the egg deposition conservation level achieved (65%) in 1999 is the third highest estimated since 1964 (Fig 6). The conservation egg deposition level achieved in Middle Barachois Brook in 1999 was very low (44%) (Fig. 7). There was no spawner survey of Middle Barachois in 1998. Snorkellers noted during the survey that they observed very few parr in the river relative to the numbers that they observed in other rivers. The lower returns of small salmon to Crabbes River in 1998 and 1999 and the returns of small salmon in 1999 in Middle Barachois Brook may have been related to the severe flows that occurred in February 1996. This flood moved a considerable amount of substrate, which may have caused a high mortality in juvenile salmon. Dempson and Clarke (1999) provided a discussion of this high discharge event on Highlands River.

The spawning escapements in Fischells Brook showed a marked increase in 1999 over 1998. No apparent explanation is available to explain this large increase. Although a portion of the

increase may have been due to the fact that a section of the river called the "steadies", not surveyed in 1998, was surveyed in 1999. A decision was made in 1998 not to survey the "steadies" because during the 1997 survey no salmon were found in this section. However, in 1999, there were 41 large salmon and 100 small salmon counted in the "steadies", about 10% of the total unadjusted count for the river. The egg deposition conservation level achieved (110%) in Fischells Brook in 1999 is the highest estimated, 1953-99 (Fig. 7).

The spawning escapements and egg depositions estimated for Robinsons River and Flat Bay Brook are improvements over those observed in 1997 and continue an increasing trend that began in 1993 (Table 10 and 13). The conservation egg deposition levels achieved for these rivers, in 1999, are the highest in more than 15 years (Fig 6 and 7). Flat Bay Brook was closed to all angling in 1995 and 1996, and was closed to retention from 1997 to 1999. Robinsons was closed to retention angling from 1996 to 1999. Given the increasing trends in returns in recent years, a small fishing mortality on small salmon in year 2000 could occur, and the rivers would still achieve its conservation egg deposition requirements.

Unfed Atlantic salmon fry were stocked in Flat Bay Brook in 1995, 1996 and 1997. The fry were incorporated, as egg equivalents, into the percentage conservation egg deposition achieved in 1994, 1995 and 1996 (Table 13) (Bourgeois et al 1997).

The proportions of the spawning escapements that were large salmon, as estimated from the visual surveys in 1999, were similar to those estimated in Crabbes River, Robinsons River, and Flat Bay Brook in previous years (see the text Table below). In Middle Barachois and Fischells brooks the proportions of large salmon were more variable.

	Percent large salmon			
	1996	1997	1998	1999
Crabbes River	22.1	23.6	26.2	24.9
Middle Barachois Brook	4.3	14.9	N/A	9.9
Robinsons River	13.5	14.5	N/A	13.5
Fischells Brook	N/A	10.8	27.0	18.1
Flat Bay Brook	9.7	11.5	N/A	10.5

The application of the empirical biological characteristics data for Middle Barachois Brook resulted in a reduction in the estimates of egg deposition by 37% in 1996 and 36% in 1997. The proportion large salmon (34%) observed in the sampling on Middle Barachois in 1998, (Appendix 6), were not used because there might have been a sampling bias since samples were taken from one location in the river and the sampling was in a different year. River specific data on weights and sex ratio are required to improve the stock assessment for Crabbes and Robinsons rivers and Fischells and Flat Bay brooks.

The small salmon sampled in Middle Barachois Brook in 1998 consisted of 70.0% virgin 1SW salmon and 11.4% virgin 2SW salmon. There was only one fish aged as virgin 1SW salmon in the large category. In the small category all of the virgin 1SW salmon were 54.0 cm or less; and, all of the virgin 2 SW salmon (in the small category) were between 60.0 cm and 62.5 cm

(Appendix 6). Also about 27% of the virgin 2 SW salmon were <63 cm, which has management implications. An objective fisheries management is to minimise the harvest of virgin 2 SW salmon in the recreational fishery. This objective is being achieved by prohibiting the retention of salmon >63 cm. This objective would be more effectively attained on Middle Barachois Brook by prohibiting the retention of salmon >60 cm.

Few net marks were observed, for three consecutive years, on the salmon, which suggests that few salmon encountered nets at sea or in the rivers.

The information available did not lend itself to forecasting the abundance of salmon in 2000.

The origins of the two rainbow trout observed in each of Flat Bay Brook and Robinsons River are not known. There was a previous record of a rainbow trout captured, in 1995, in a fish counting fence on Flat Bay Brook (Bourgeois, pers. comm.). It was a male and measured 38.7cm. There are no known natural populations of rainbow trout in Bay St. George. Marine cage rearing of rainbow trout occurs in Bay d'Espoir, Newfoundland and Cape Breton Island, Nova Scotia.

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References

Anon 1998. Effects of hook-and-release angling practises. DFO Stock Status Report DO-03 (1998), 8pp.

Bourgeois, C. E, J. P. Davis, J. Murray and V. Mercer. 1997. Status of three Atlantic salmon (*Salmon salar* L.) stocks of the Newfoundland Region in 1996. DFO Can. Stock Assessment Secretariat Res. Doc.1997/33, 33pp.

Brobbel, M. A., M. P. Wilkie, J.D. Kieffer, and B. L. Tufts. 1996. Physiological effects of catch and release angling in Atlantic salmon (*Salmo salar*) at different stages of freshwater migration. Can. J. Fish. Aquat. Sci. 53: 2036-2043.

Chadwick, E. M. P., R. Porter, and D. Reddin. 1978. Atlantic salmon management program, Newfoundland and Labrador, 1978. Atl. Salmon J. 1978(1) 9-15.

Dempson, J. B, and G. Clarke. 1998. Status of Atlantic salmon at Highlands River, Bay St. George, SFA 13, Newfoundland, 1998. DFO Can. Stock Assessment Secretariat Res. Doc.1999/93, 44pp.

O'Connell, M. F., N. M. Cochrane, and C. C. Mullins. 1998. An analysis of the license stub return system in the Newfoundland Region, 1994-97. DFO, Can. Stock Assessment Secretariat Res. Doc. 98/111.

O'Connell, M. F., and J. B. Dempson. 1995. Target spawning requirements for Atlantic salmon, *Salmo salar* L., in Newfoundland rivers. Fisheries Management and Ecology 2: 161-170.

Porter, T. Rex. 1997. Status of Atlantic salmon (*Salmon salar* L.) Populations in Crabbes, Robinsons, and Middle Barachois Rivers, Bay St. George, Newfoundland, 1996. DFC Can. Stock Assessment Secretariat Res. Doc.1997/43, 25 pp.

Porter, T. R. 1999. Status of Atlantic salmon (*Salmon salar* L.) populations in Crabbes River and Fischells Brook, Bay St. George, Newfoundland, 1998. DFO Can. Stock Assessment Secretariat Res. Doc.1999/95. 20 pp

Porter, T. R. and C. E. Bourgeois. 1998. Status of Atlantic salmon (Salmo salar L.) populations in Crabbes and Robinsons river, and Middle Barachois, Fischells, and Flat Bay brooks, bay St. George, Newfoundland, 1997. DFO Can. Stock Assessment Secretariat Res. Doc.1998/112, 35 pp.

Porter, T. R., and E. M. P. Chadwick. 1983. Assessment of Atlantic salmon stocks in Statistical Areas K and L, Western Newfoundland, 1982. CAFSAC Res. Doc. 83/87, 84 p.

Reddin, D. G. and C. C. Mullins. 1996. Status of Atlantic Salmon (*Salmo salar*) in eleven rivers of Bay St. George (SFA 13), Newfoundland, 1994. DFO Atlantic Fisheries Res. Doc. 96/86, 71p.

Wilkie, M. P., K. Davidson, M. A. Brobbel, J.D. Kieffer, R. K. Booth, A. T. Bielak, and B. L. Tufts. 1996. Physiology and survival of wild salmon following angling in warm summer waters. Trans. Am. Fish. Soc. 125: 572-580.

Table 1. Drainage area, fluvial habitat, and egg deposition levels required for conservation in five rivers in Bay St. George.

River Name	Drainage Area (sq. km)	Fluvial Rearing Units (100 sq. m)	Standing Water (ha)	Conservation Requirement Eggs (x 10**6)
CrabbesRiver	551	18,429	381	4.6
Middle Barachois Brook	241	8,395	362	2.1
Robinsons River	439	13,491	124	3.3
Fischells River	360	13,661	948	3.6
Flat Bay Brook	635	16,012		3.8
Total	2,226	40,315	42,541	17.4

Table 2. Seasons and quotas for small salmon (< 63 cm) in the angling fishery for five rivers in SFA 13, 1953-99.

Years	Crabbes	M. Barachois (Quota)	Robinsons (Quota)	Fischells (Quota)	Flat Bay (Quota)
1953-77	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep
1978-84	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug
1985	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep
1986	1 Jun – 7 Sep	1 Jun – 7 Sep (350)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (400)
1987	1 Jun – 7 Sep	1 Jun – 7 Sep (350)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (300)
1988	1 Jun – 7 Sep	1 Jun – 7 Sep (175)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (300)
1989-94	1 Jun – 7 Sep	1 Jun – 7 Sep (175)	1 Jun – 7 Sep	1 Jun – 7 Sep (200)	1 Jun – 7 Sep (250)
1995	3 Jun – 17 Sep	3 Jun – 17 Sep (175)	3 Jun – 17 Sep	3 Jun – 17 Sep (200)	Closed
1996	1 Jun – 2 Sep (0)	1 Jun – 2 Sep (0)	1 Jun – 2 Sep (0)	1 Jun – 2 Sep	Closed
1997	1 Jun – 1 Sep (0)	1 Jun – 1 Sep (0)	1 Jun – 1 Sep (0)	1 Jun – 1 Sep	1 Jun – 1 Sep (0)
1998	6 Jun – 7 Sep (0)	6 Jun – 7 Sep (0)	6 Jun – 7 Sep (0)	6 Jun – 7 Sep (0)	6 Jun – 7 Sep (0)
1999	1 Jun – 7 Sep (0)	1 Jun – 7 Sep (0)	1 Jun – 7 Sep (0)	(Closed)	1 Jun – 7 Sep (0)

Table 3. Biological characteristics of salmon in five Bay St. George rivers.

River	Small salmon			Large salmon		
	% Female	Mean Wt(kg)	Mean Lth(cm)	% Female	Mean Wt(kg)	Mean Lgth(cm)
Crabbes	71.9	1.63	N/A	86.8	5.06	N/A
Middle Barachois	54.3	1.4	51.9	94.1	2.9	67.0
Robinsons	71.9	1.63	N/A	86.8	5.06	N/A
Fischells	71.9	1.63	N/A	86.8	5.06	N/A
Flat Bay	71.9	1.34	53.4	66.7	3.31	69.1

Table 4. Number of salmon released in the angling fishery on four Bay St. George rivers, 1999. Mortality is assumed to be 10% of the released salmon. Percent (%) of returns is the percent of total returns to the river

	Crabbes		M. Barachois		Robinsons		Flat Bay	
Small Salmon	Fish	% of returns	Fish	% of returns	Fish	% of returns	Fish	% of returns
Released	29	4.2	33	5.9	320	22.3	235	10.4
Estimated Mortality	3	0.4	3	0.5	32	2.2	24	1.1
Large Salmon								
Released	12	4.6	6	9.0	37	18.2	35	14.9
Estimated Mortality	1	0.4	1	1.5	4	2.0	4	1.7

Table 5. Number of small and large salmon counted in Crabbes River, 23, 24 and 28 August 1999. Little Crabbes surveyed Sept 11 by River Monitors.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	6	153	21	1.10	168	23	191	0.12
2	7	197	97	1.15	227	112	338	0.33
Gorge*		11	1		68	12	80	0.15
3	3	97	59	1.30	126	77	203	0.38
4	3	39	25	1.20	47	30	77	0.39
5		Not Surveyed			30	6	36	0.17
L Crabbes		17	4	1.00	17	4	21	
TOTAL	19	514	207	1.31	683	263	946	27.8

Table 6. Number of small and large salmon counted in Middle Barachois Brook, 28 August 1999.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	6	225	28	1.05	236	29	266	11.1
2	6	238	21	1.20	286	25	311	8.1
3	1	21	3	1.50	32	5	36	12.5
4	0	2	6	1.10	2	7	9	0.0
Big Dribble		Not surveyed			0	0	0	0.0
TOTAL	13	486	58	1.14	556	66	621	10.6

Table 7. Number of small and large salmon counted in Robinsons River, 26-27 August 1999 Northern Feeder surveyed on September 9, 1999.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	8	357	64	1.25	446	80	526	15.2
2	10	692	89	1.10	761	98	859	11.4
3	2	98	14	1.10	108	15	123	12.5
4	2	70	5	1.20	84	6	90	6.7
N. Feeder	0	0	0	1.00	0	0	0	0.0
TOTAL	22	1217	172	1.15	1399	199	1599	12.5

Table 8. Number of small and large salmon counted in Fischells Brook, 25 and 27 August 1999.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	7	290	85	1.15	334	98	431	22.7
2	10	510	94	1.10	561	103	664	15.6
3	4	236	32	1.15	271	37	308	11.9
4	2	89	7	1.10	98	8	106	7.3
TOTAL	23	1125	218	1.12	1264	246	1509	16.3

Table 9. Number of small and large salmon counted in Flat Bay Brook, 27& 29 August 1999

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1&2	6	491	55	1.15	565	63	628	10.1
3	2	79	14	1.05	83	15	98	15.1
4	12	1142	104	1.10	1,256	114	1,371	8.3
5	1	38	2		333	38	372	10.3
TOTAL	21	1750	175	1.28	2237	231	2468	9.4

Table 10. Spawning escapements of Atlantic salmon to five Bay St. George rivers, 1953-99. Table is an update from Porter and Bourgeois (1998) and Porter (1999).

Year	Crabbes		M. Barachois		Robinsons		Fishells		Flat Bay	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1953	166	51	54	6	1141	228	226	57	1554	179
1954	271	77	77	21	863	305	79	65	768	69
1955	177	149	63	23	847	159	75	68	1006	50
1956	420	329	532	105	1372	299	343	104	1321	44
1957	772	467	390	102	1857	267	425	117	1675	29
1958	313	411	254	131	840	447	364	149	1447	59
1959	551	276	138	24	1139	147	336	47	779	27
1960	343	75	201	23	1773	176	222	57	2357	98
1961	756	168	502	38	1708	249	450	108	1783	53
1962	1328	294	551	71	2345	176	658	86	3215	111
1963	1092	450	632	218	2814	585	992	180	4263	138
1964	1909	437	798	149	2182	423	712	204	4324	146
1965	1003	363	1265	167	2382	300	471	126	1815	263
1966	293	127	229	74	616	116	64	45	704	27
1967	593	164	667	130	1035	136	434	33	1098	52
1968	552	186	749	101	984	120	339	36	1162	33
1969	1018	191	936	126	693	60	508	63	1047	78
1970	370	123	455	56	634	65	369	110	1828	94
1971	379	70	672	44	456	47	292	22	1245	65
1972	486	124	425	151	351	34	163	52	1074	58
1973	407	87	694	63	1002	70	490	66	851	69
1974	359	80	314	57	433	14	269	22	623	48
1975	330	74	623	96	747	34	225	17	499	34
1976	233	47	643	38	680	46	226	13	744	39
1977	265	103	653	46	493	151	299	54	255	21
1978	333	270	234	1057	592	318	397	321	208	4
1979	553	30	568	0	1248	108	173	0	107	1
1980	877	193	1329	249	1724	529	585	415	662	8
1981	940	244	962	31	2170	604	701	114	680	12
1982	1355	159	628	21	2281	192	919	73	635	10
1983	254	97	385	10	592	42	330	79	458	2
1984	952	30	724	0	1265	108	551	83	483	2
1985	129	30	160	40	507	67	216	20	390	22
1986	472	108	326	82	463	61	274	26	224	13
1987	114	26	83	21	313	41	88	8	282	16
1988	386	89	329	83	394	52	556	53	321	18
1989	64	15	129	33	158	21	25	2	167	10
1990	152	35	225	57	315	42	173	16	357	20
1991	140	32	111	28	239	32	234	22	323	18
1992	393	126	362	72	557	130	210	21	287	25
1993	204	34	435	36	306	31	234	65	223	21
1994	600	113	578	81	750	115	844	158	243	67
1995	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	567	44
1996	844	239	805	36	768	120	N/A	N/A	1051	112
1997	1121	346	1044	182	1017	172	599	73	1282	167
1998	482	171	N/A	N/A	N/A	N/A	194	72	N/A	N/A
1999	683	263	556	66	1399	199	1264	246	2237	231
Mean 53-65	700	273	420	83	1636	289	412	105	2024	97
Mean 66-77	441	115	588	82	677	74	306	44	928	52
Mean 78-84	752	146	690	195	1410	272	522	155	462	6
Mean 85-91	208	48	195	49	341	45	224	21	295	17
Mean 92-94	399	91	459	63	538	92	429	82	289	39
Mean 96-98	816	252	925	109	893	146	397	73	1167	140

Table 11. Estimated total returns of Atlantic salmon to five Bay St. George rivers, 1953-99. Table is an update from Porter and Bourgeois (1998), and Porter (1999).

	Crabbes		Middle Barachois		Robinsons		Fishells		Flat Bay	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1953	237	85	77	10	1630	380	323	95	2220	298
1954	387	128	110	35	1233	508	113	108	1097	115
1955	253	248	90	38	1210	265	107	113	1437	83
1956	600	548	760	175	1960	498	490	173	1887	73
1957	1103	778	557	170	2653	445	607	195	2393	48
1958	447	685	363	218	1200	745	520	248	2067	98
1959	787	460	197	40	1627	245	480	78	1113	45
1960	490	125	287	38	2533	293	317	95	3367	163
1961	1080	280	717	63	2440	415	643	180	2547	88
1962	1897	490	787	118	3350	293	940	143	4593	185
1963	1560	750	903	363	4020	975	1417	300	6090	230
1964	2727	728	1140	248	3117	705	1017	340	6177	243
1965	1433	605	1807	278	3403	500	673	210	2593	438
1966	533	282	416	164	1120	258	116	100	1280	60
1967	1078	365	1213	289	1882	302	789	73	1996	115
1968	1004	413	1362	225	1789	267	616	80	2113	73
1969	1851	425	1702	280	1260	133	924	140	1904	173
1970	673	273	827	125	1153	145	671	245	3324	209
1971	689	155	1222	98	829	104	531	49	2264	145
1972	884	276	773	335	638	75	296	115	1953	129
1973	740	193	1262	140	1822	155	891	147	1547	153
1974	653	178	571	127	787	31	489	49	1133	107
1975	600	164	1133	213	1358	76	409	38	907	76
1976	424	105	1169	84	1236	102	411	29	1353	87
1977	482	229	1187	102	896	335	544	120	464	47
1978	471	397	285	1159	827	386	551	352	348	16
1979	782	44	692	0	1743	131	240	0	179	5
1980	1240	284	1619	273	2408	642	812	455	1107	34
1981	1329	359	1172	34	3031	733	973	125	1137	51
1982	1916	234	765	23	3186	233	1276	80	1062	43
1983	359	119	469	11	827	51	458	80	766	9
1984	1346	44	882	0	1767	131	765	91	808	9
1985	224	30	258	40	880	67	361	20	693	22
1986	819	108	526	82	804	61	458	26	398	13
1987	198	26	134	21	543	41	147	8	501	16
1988	670	89	531	83	684	52	930	53	570	18
1989	111	15	208	33	274	21	42	2	297	10
1990	264	35	363	57	547	42	289	16	634	20
1991	243	32	179	28	415	32	391	22	574	18
1992	682	126	584	72	967	130	351	21	510	25
1993	354	34	665	36	531	31	391	65	396	21
1994	774	113	732	81	910	115	1060	158	420	70
1995	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	650	48
1996	866	249	825	40	866	137	N/A	N/A	1233	132
1997	1152	358	1060	190	1077	190	797	86	1307	173
1998	491	177	N/A	N/A	N/A	N/A	215	72	N/A	N/A
1999	686	264	559	67	1431	203	1264	246	2261	235
Mean 53-65	1000	454	599	138	2337	482	588	175	2891	162
Mean 66-77	801	255	1070	182	1231	165	557	99	1687	115
Mean 78-84	1063	212	840	214	1970	330	725	169	772	24
Mean 85-91	361	48	314	49	592	45	374	21	524	17
Mean 92-94	603	91	661	63	803	92	600	82	463	39
Mean 96-98	836	261	943	115	972	164	506	79	1270	153

Table 12. Adjusted and unadjusted numbers of small and large Atlantic salmon spawners, estimated egg deposition, and percentage of egg deposition required for conservation that was attained in five Bay St. George rivers,in 1999.

River	Small salmon		Large salmon		Egg deposition		% Conservation level	
	unadjusted	adjusted	unadjusted	adjusted	unadjusted	adjusted	unadjusted	adjusted
Crabbes River	514	683	207	263	2327792	3011582	51	65
M. Barachois Bk	486	556	58	66	812709	928279	39	44
Robinsons River	1217	1396	172	199	3359857	3865545	102	117
Fischells River	1125	1264	218	246	3504947	3945206	97	110
Flat Bay Brook	1749	2237	175	231	4402048	5657507	116	149

Table 13. Percentage of the Atlantic salmon egg deposition level required for conservation that was achieved on five rivers in Bay St. George, 1953-99. Table is updated from Porter and Bourgeois (1998) and Porter (1999).

Year	Crabbes	M. Barachois	Robinsons	Fischells	Flat Bay
1953	10	4	73	18	79
1954	15	9	75	15	36
1955	20	8	53	15	40
1956	46	52	92	30	48
1957	69	44	104	35	57
1958	52	43	95	39	55
1959	43	13	61	20	29
1960	17	16	87	18	90
1961	37	35	98	35	64
1962	64	45	107	37	118
1963	75	83	184	66	155
1964	94	76	138	61	19
1965	64	105	127	39	102
1966	19	25	32	10	27
1967	28	54	45	21	44
1968	30	51	42	18	43
1969	38	63	26	29	47
1970	20	30	25	33	75
1971	14	35	18	14	51
1972	22	50	14	15	44
1973	16	40	35	29	39
1974	15	25	13	13	28
1975	14	45	23	11	22
1976	9	32	23	10	31
1977	16	35	34	20	12
1978	38	254	70	72	7
1979	19	34	65	6	4
1980	45	136	146	96	22
1981	52	64	174	44	23
1982	55	42	117	43	21
1983	17	25	29	25	14
1984	30	43	65	33	15
1985	6	18	28	10	15
1986	24	36	25	13	8
1987	6	9	17	4	11
1988	19	37	22	26	12
1989	3	14	9	1	6
1990	8	25	17	8	13
1991	7	12	13	11	12
1992	34	53	57	14	18
1993	13	48	23	24	14
1994	41	74	65	71	19
1995	N/A	N/A	N/A	N/A	45
1996	68	52	67	N/A	85
1997	95	95	91	44	89
1998	44	N/A	N/A	23	N/A
1999	65	44	117	110	149
Mean 53-65	47	41	99	33	79
Mean 66-77	20	40	28	19	39
Mean 78-84	37	86	95	46	15
Mean 85-91	10	22	19	10	11
Mean 92-94	0	58	49	36	17
Mean 96-98	0	74	79	34	87

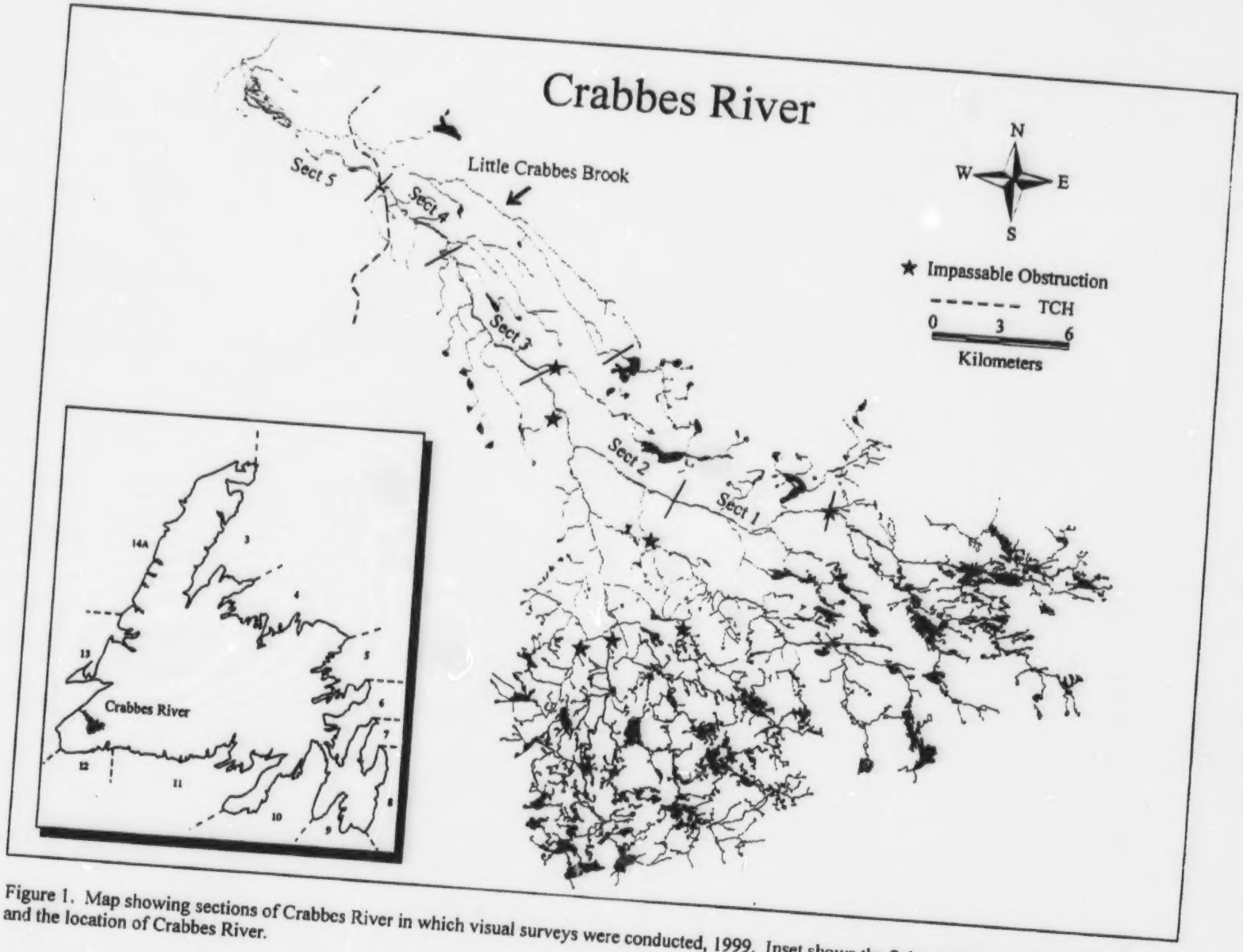

Figure 1. Map showing sections of Crabbes River in which visual surveys were conducted, 1999. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Crabbes River.

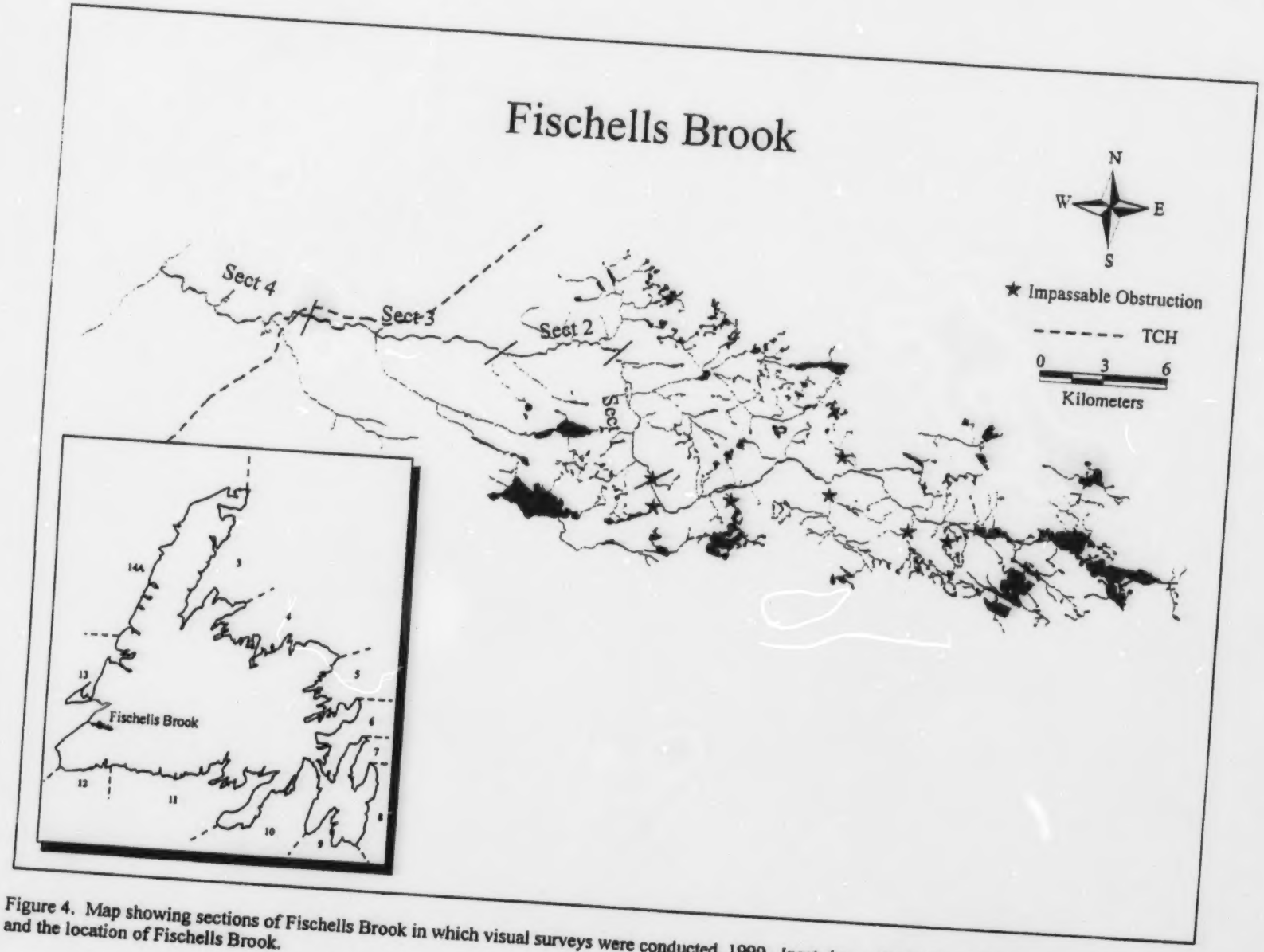

Figure 4. Map showing sections of Fischells Brook in which visual surveys were conducted, 1999. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Fischells Brook.

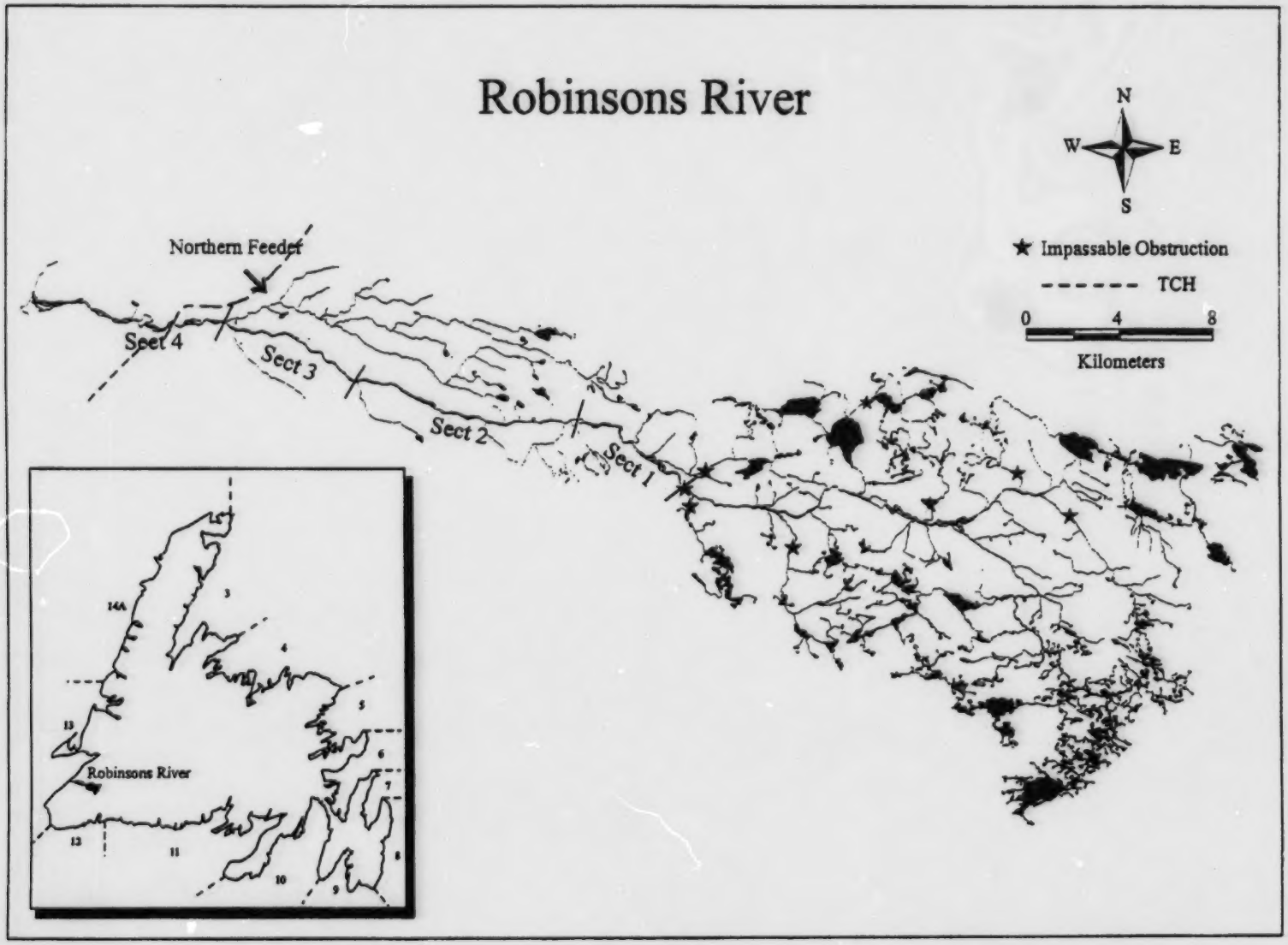

Figure 3. Map showing sections of Robinsons River in which visual surveys were conducted, 1999. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Robinsons River.

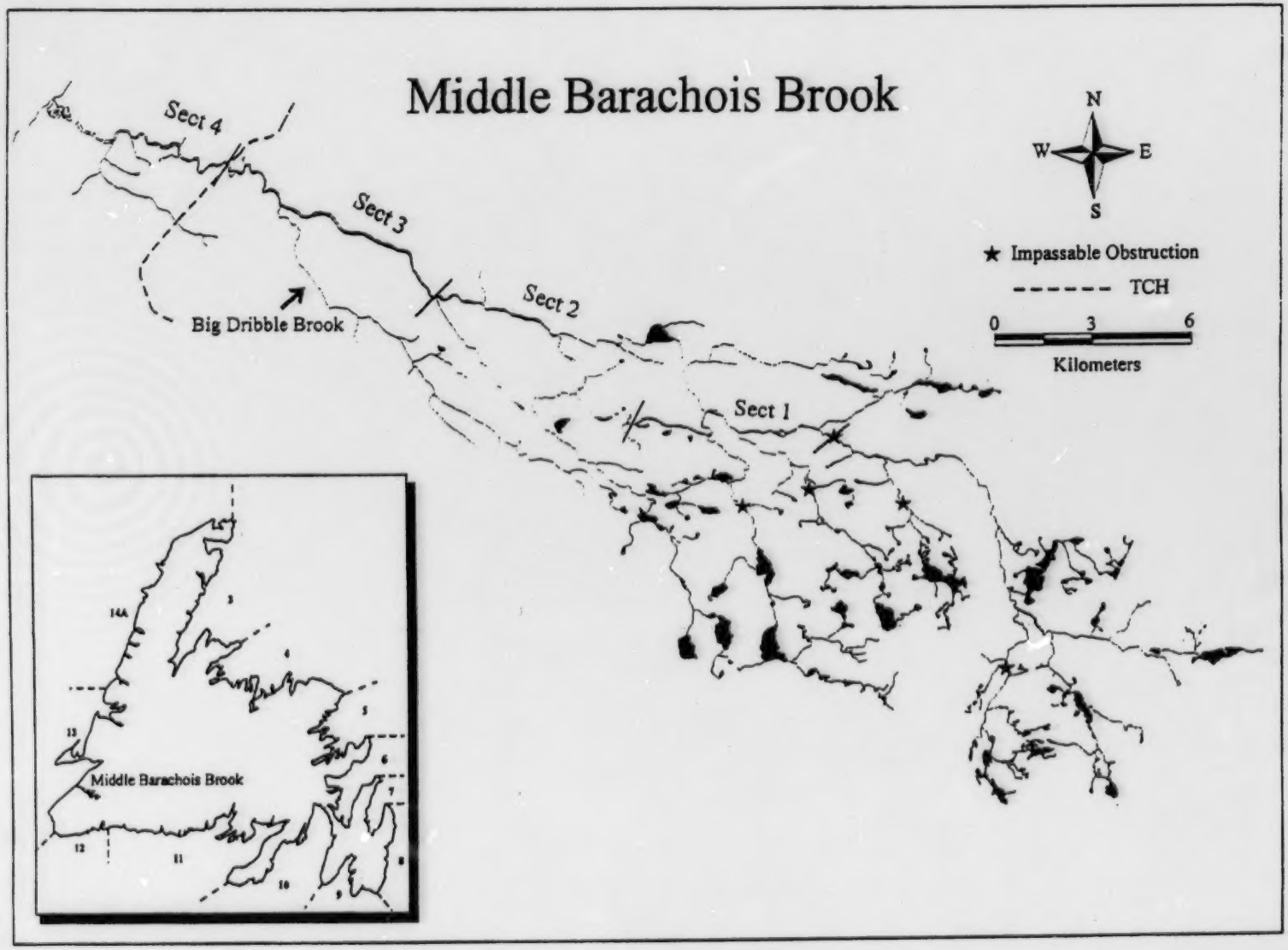

Figure 2. Map showing sections of Middle Barachois Brook in which visual surveys were conducted, 1999. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Middle Barachois Brook.

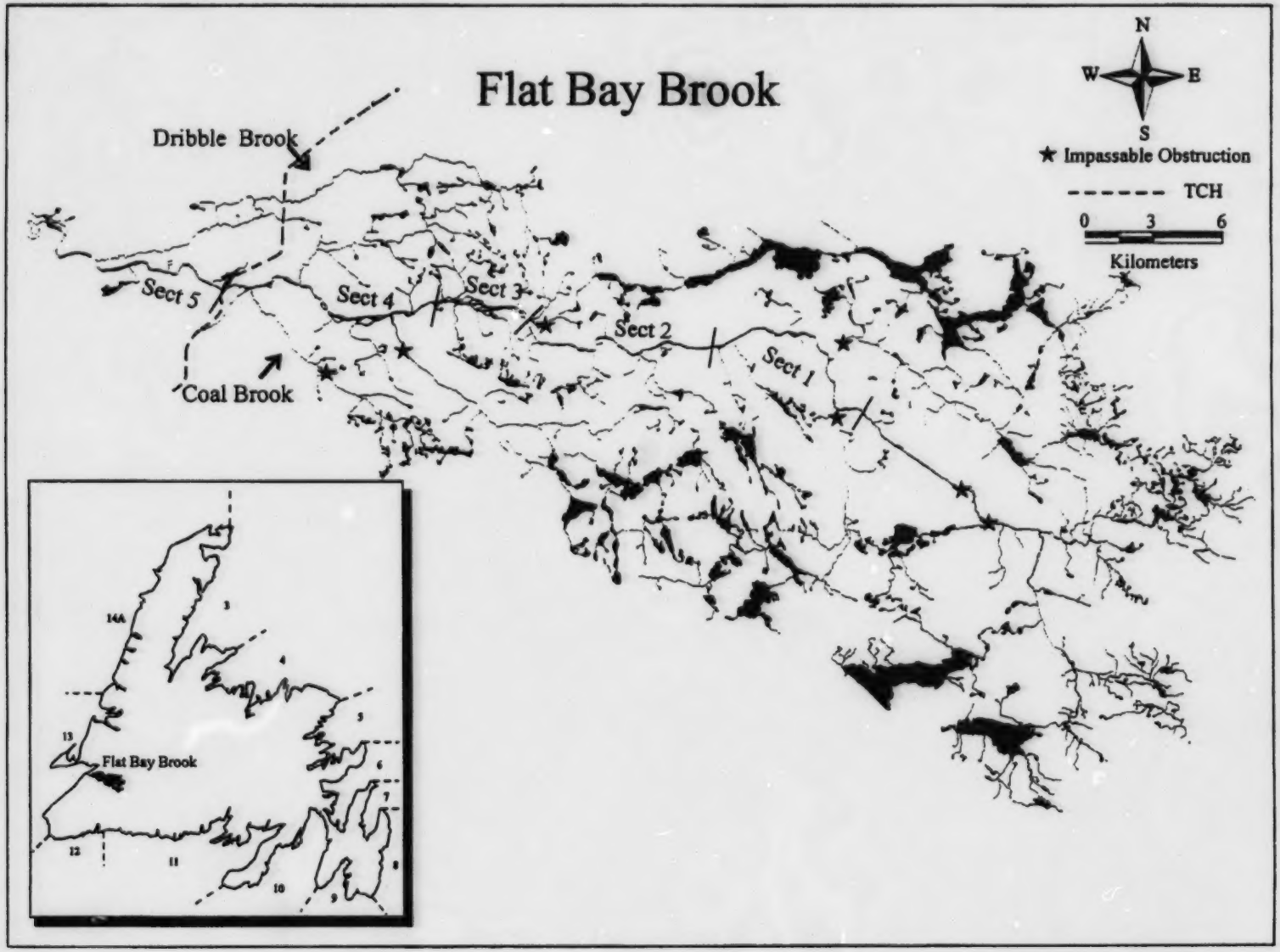

Figure 5. Map showing sections of Flat Bay Brook in which visual surveys were conducted, 1999. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Flat Bay Brook.

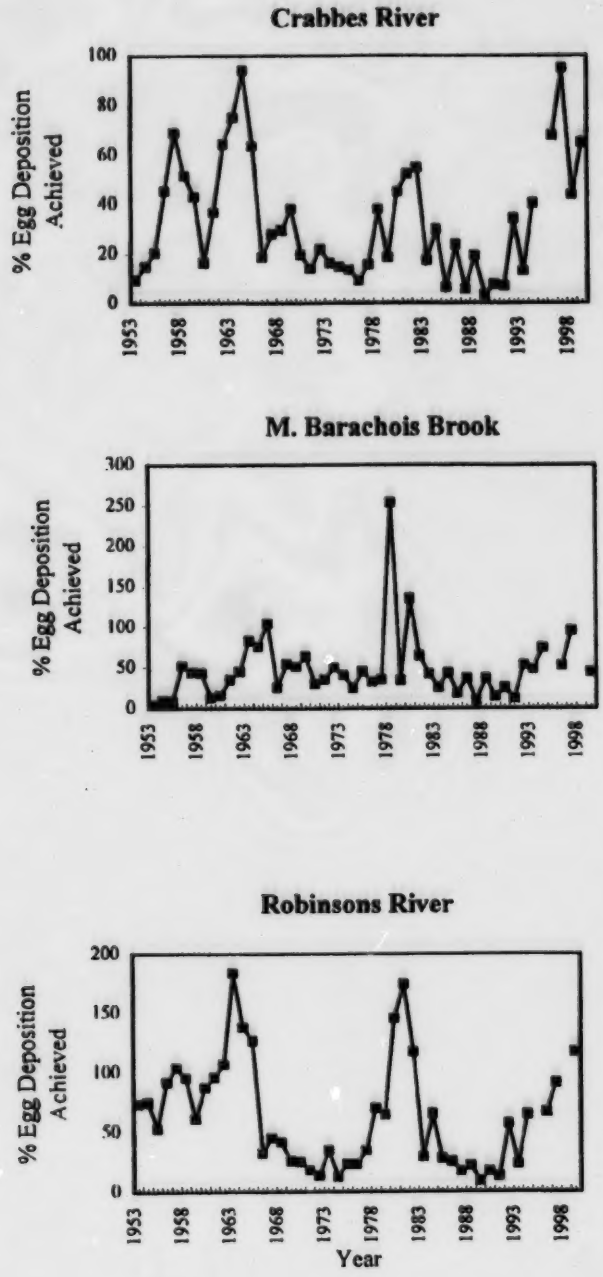

Fig. 6. Percentages of the Atlantic salmon conservation egg deposition levels that were achieved on Crabbes, Middle Barachois and Robinsons rivers 1953-99.

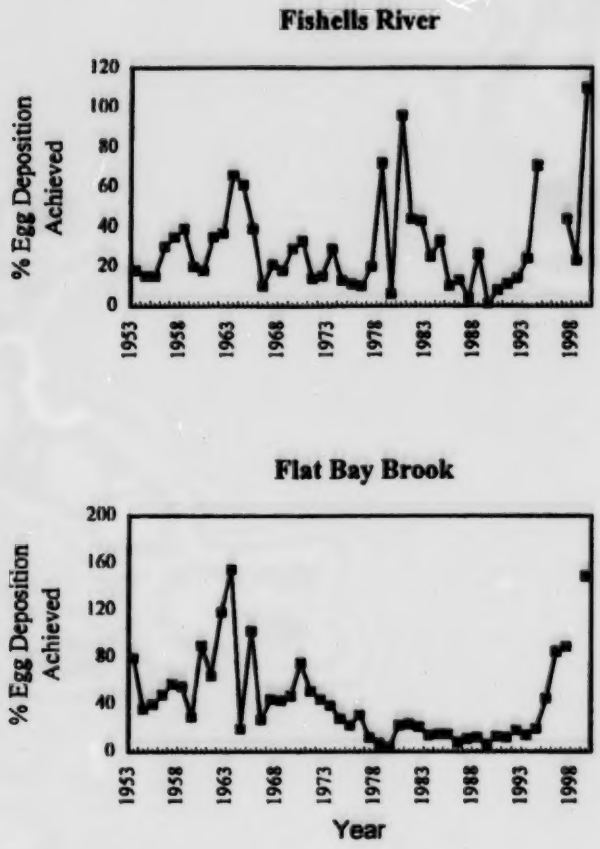

Fig. 7. Percentages of the Atlantic salmon conservation egg deposition levels that were achieved on Fischells and Flat Bay brooks 1953-99.

Appendix 1. Angling catch statistics for Crabbes River. Data for 1974-1995 were collected by DFO River Guardians, and data for 1996-1999 are from the license stub return. 1999 data are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1010	294	.	294	98	.	98	392	.	392	0.39
1975	1641	270	.	270	90	.	90	360	.	360	0.22
1976	859	191	.	191	58	.	58	249	.	249	0.29
1977	859	217	.	217	126	.	126	343	.	343	0.40
1978	907	138	.	138	127	.	127	265	.	265	0.29
1979	501	229	.	229	14	.	14	243	.	243	0.49
1980	902	363	.	363	91	.	91	454	.	454	0.50
1981	905	389	.	389	115	.	115	504	.	504	0.56
1982	1135	561	.	561	75	.	75	636	.	636	0.56
1983	758	105	.	105	38	.	38	143	.	143	0.19
1984	848	394	.	394	14	.	14	408	.	408	0.48
1985	602	95	.	95	*	3	3	95	3	98	0.16
1986	997	347	.	347	*	0	0	347	0	347	0.35
1987	377	84	.	84	*	4	4	84	4	88	0.23
1988	773	284	.	284	*	17	17	284	17	301	0.39
1989	419	47	.	47	*	5	5	47	5	52	0.12
1990	457	112	.	112	*	25	25	112	25	137	0.30
1991	385	103	.	103	*	9	9	103	9	112	0.29
1992	822	263	26	289	*	88	88	263	114	377	0.46
1993	737	150	0	150	*	24	24	150	24	174	0.24
1994	906	174	37	211	*	45	45	174	82	256	0.28
1995	268	26	5	31	*	32	32	26	37	63	0.24
1996**		-	221	221	*	96	96	-	317	317	
1997**		3	278	281	*	119	119	3	397	400	
1998**		-	91	91	*	55	55	-	146	146	
1999**		-	29	29	*	12	12	-	41	41	
84-89 $\bar{X}$	669.3	208.5	.	208.5	.	5.8	7.2	210.8	5.8	215.7	0.32
95% CL	258.3	158.3	.	158.3	.	8.1	7.1	162.0	8.1	161.6	0.14
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	568.0	162.8	.	162.8	.	10.0	10.0	162.8	10.0	172.8	0.30
95% CL	269.9	128.0	.	128.0	.	9.8	9.8	128.0	9.8	127.3	0.09
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	683.3	153.3	17.0	170.3	.	47.3	47.3	153.3	64.3	217.5	0.32
95% CL	453.9	155.6	27.8	173.2	.	45.4	45.4	155.6	65.9	210.8	0.18
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN; 1999 DATA ARE PRELIMINARY

1996-1999 CATCH AND RELEASE ONLY.

Appendix 2. Angling catch statistics for Middle Barachois Brook. Data for 1974-1995 were collected by DFO River Guardians, and data for 1996-1999 are from the license stub return. 1999 data are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	894	257	.	257	70	.	70	327	.	327	0.37
1975	1129	510	.	510	117	.	117	627	.	627	0.56
1976	1572	526	.	526	46	.	46	572	.	572	0.36
1977	1218	534	.	534	56	.	56	590	.	590	0.48
1978	273	51	.	51	102	.	102	153	.	153	0.56
1979	342	124	.	124	0	.	0	124	.	124	0.36
1980	622	290	.	290	24	.	24	314	.	314	0.50
1981	487	210	.	210	3	.	3	213	.	213	0.44
1982	313	137	.	137	2	.	2	139	.	139	0.44
1983	292	84	.	84	1	.	1	85	.	85	0.29
1984	320	158	.	158	0	.	0	158	.	158	0.49
1985	422	98	.	98	*	1	1	98	1	99	0.23
1986	683	200	.	200	*	23	23	200	23	223	0.33
1987	208	51	.	51	*	0	0	51	0	51	0.25
1988	565	202	.	202	*	11	11	202	11	213	0.38
1989	395	79	.	79	*	1	1	79	1	80	0.20
1990	547	138	.	138	*	7	7	138	7	145	0.27
1991	293	68	.	68	*	6	6	68	6	74	0.25
1992	535	222	0	222	*	22	22	222	22	244	0.46
1993	916	230	23	253	*	11	11	230	34	264	0.29
1994	785	154	25	179	*	14	14	154	39	193	0.25
1995	341	53	2	55	*	24	24	53	26	79	0.23
1996**		-	195	195	*	35	35	-	230	230	
1997**		-	158	158	*	81	81	-	239	239	
1998**		-	6	6	*	23	23	-	29	29	
1999**		-	33	33	*	6	6	-	39	39	
84-89 $\bar{X}$	432.2	131.3	.	131.3	.	7.2	6.0	131.3	7.2	137.3	0.32
95% CL	178.7	67.6	.	67.6	.	12.3	9.8	67.6	12.3	75.3	0.10
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	448.5	123.0	.	123.0	.	8.0	8.0	123.0	8.0	131.0	0.29
95% CL	189.6	70.5	.	70.5	.	8.8	8.8	70.5	8.8	78.0	0.07
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	644.3	164.8	12.5	177.3	.	17.8	17.8	164.8	30.3	195.0	0.30
95% CL	408.3	130.4	21.2	138.4	.	9.9	9.9	130.4	12.2	131.9	0.14
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
**DATA OBTAINED FROM THE LICENSE STUB RETURN;
1996-1999 CATCH AND RELEASE ONLY.

Appendix 3. Angling catch statistics for Robinsons River. Data for 1974-1995 were collected by DFO River Guardians, and data for 1996-1999 are from the license stub return. 1999 data are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	1134	354	.	354	17	.	17	371	.	371	0.33
1975	1556	611	.	611	42	.	42	653	.	653	0.42
1976	1842	556	.	556	56	.	56	612	.	612	0.33
1977	1184	403	.	403	184	.	184	587	.	587	0.50
1978	671	235	.	235	68	.	68	303	.	303	0.45
1979	989	495	.	495	23	.	23	518	.	518	0.52
1980	1352	684	.	684	113	.	113	797	.	797	0.59
1981	1527	861	.	861	129	.	129	990	.	990	0.65
1982	1648	905	.	905	41	.	41	946	.	946	0.57
1983	2580	278	.	278	210	.	210	488	.	488	0.19
1984	1884	502	.	502	23	.	23	525	.	525	0.28
1985	1905	373	.	373	*	7	7	373	7	380	0.20
1986	2344	341	.	341	*	37	37	341	37	378	0.16
1987	1276	230	.	230	*	15	15	230	15	245	0.19
1988	1528	290	.	290	*	9	9	290	9	299	0.20
1989	971	116	.	116	*	11	11	116	11	127	0.13
1990	1182	232	.	232	*	22	22	232	22	254	0.21
1991	818	176	.	176	*	10	10	176	10	186	0.23
1992	1552	386	24	410	*	75	75	386	99	485	0.31
1993	1284	225	0	225	*	18	18	225	18	243	0.19
1994	1051	160	88	248	*	38	38	160	126	286	0.27
1995	719	73	38	111	*	23	23	73	61	134	0.19
1996**		5	926	931	*	168	168	5	1094	1099	
1997**		3	571	574	*	184	184	3	755	758	
1998**		4	468	472	*	114	114	4	582	586	
1999**		-	320	320	*	37	37	-	357	357	
84-89 $\bar{X}$	1651.3	308.7	.	308.7	.	15.8	17.0	312.5	15.8	325.7	0.20
95% CL	517.9	137.8	.	137.8	.	15.2	11.9	145.1	15.2	142.5	0.05
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	1353.2	230.8	.	230.8	.	17.3	17.3	230.8	17.3	248.2	0.18
95% CL	571.1	83.7	.	83.7	.	11.3	11.3	83.7	11.3	91.5	0.03
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	1151.5	211.0	37.5	248.5	.	38.5	38.5	211.0	76.0	287.0	0.25
95% CL	562.6	210.4	59.1	196.0	.	41.0	41.0	210.4	74.7	233.4	0.11
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN;

1996-1999 CATCH AND RELEASE ONLY.

Appendix 4. Angling catch statistics for Fischells Brook. Data for 1974-1995 were collected by DFO River Guardians, data for 1996-98 are from the license stub return.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	753	220	.	220	27	.	27	247	.	247	0.33
1975	522	184	.	184	21	.	21	205	.	205	0.39
1976	418	185	.	185	16	.	16	201	.	201	0.48
1977	468	245	.	245	66	.	66	311	.	311	0.66
1978	292	154	.	154	31	.	31	185	.	185	0.63
1979	168	67	.	67	0	.	0	67	.	67	0.40
1980	386	227	.	227	40	.	40	267	.	267	0.69
1981	463	272	.	272	11	.	11	283	.	283	0.61
1982	651	357	.	357	7	.	7	364	.	364	0.56
1983	377	128	.	128	7	.	7	135	.	135	0.36
1984	411	214	.	214	8	.	8	222	.	222	0.54
1985	373	145	.	145	*	3	3	145	3	148	0.40
1986	427	184	.	184	*	4	4	184	4	188	0.44
1987	266	59	.	59	*	2	2	59	2	61	0.23
1988	840	374	.	374	*	7	7	374	7	381	0.45
1989	110	17	.	17	*	0	0	17	0	17	0.15
1990	256	116	.	116	*	12	12	116	12	128	0.50
1991	414	157	.	157	*	16	16	157	16	173	0.42
1992	384	133	8	141	*	11	11	133	19	152	0.40
1993	819	157	0	157	*	34	34	157	34	191	0.23
1994	702	216	58	274	*	47	47	216	105	321	0.46
1995	555	80	112	192	*	43	43	80	155	235	0.42
1996**		315	232	547	*	150	150	315	382	697	
1997**		182	162	344	*	127	127	182	289	471	
1998**		17	36	53	*	4	4	17	40	57	
1999**		.	.	.	*	.	.	.	.	.	
84-89 $\bar{X}$	404.5	165.5	.	165.5	.	3.2	4.0	166.8	3.2	169.5	0.42
95% CL	255.9	132.8	.	132.8	.	3.2	3.2	133.4	3.2	135.5	0.10
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	385.5	151.2	.	151.2	.	6.8	6.8	151.2	6.8	158.0	0.41
95% CL	263.9	131.5	.	131.5	.	6.5	6.5	131.5	6.5	133.6	0.09
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	615.0	146.5	44.5	191.0	.	33.8	33.8	146.5	78.3	224.8	0.37
95% CL	299.3	89.7	82.4	94.3	.	25.6	25.6	89.7	100.9	115.5	0.20
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN.

1998 CATCH AND RELEASE ONLY; RIVER CLOSED TO ANGLING IN 1999.

Appendix 5. Angling catch statistics for Flat Bay Brook. Data for 1974-1994 were collected by DFO River Guardians. During 1995 and 1996 this river was closed to angling. Data for 1997-99 are from the license stub return. 1999 data are preliminary.

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	2156	510	.	510	59	.	59	569	.	569	0.26
1975	2625	408	.	408	42	.	42	450	.	450	0.17
1976	1705	609	.	609	48	.	48	657	.	657	0.39
1977	1045	209	.	209	26	.	26	235	.	235	0.22
1978	537	140	.	140	12	.	12	152	.	152	0.28
1979	263	72	.	72	4	.	4	76	.	76	0.29
1980	932	445	.	445	26	.	26	471	.	471	0.51
1981	1299	457	.	457	39	.	39	496	.	496	0.38
1982	1357	427	.	427	33	.	33	460	.	460	0.34
1983	1123	308	.	308	7	.	7	315	.	315	0.28
1984	602	325	.	325	7	.	7	332	.	332	0.55
1985	1060	303	.	303	*	6	6	303	6	309	0.29
1986	684	174	.	174	*	2	2	174	2	176	0.26
1987	816	219	.	219	*	0	0	219	0	219	0.27
1988	871	249	.	249	*	5	5	249	5	254	0.29
1989	612	130	.	130	*	1	1	130	1	131	0.21
1990	939	277	.	277	*	6	6	277	6	283	0.30
1991	977	251	.	251	*	2	2	251	2	253	0.26
1992	666	211	12	223	*	20	20	211	32	243	0.36
1993	678	173	0	173	*	17	17	173	17	190	0.28
1994	615	128	8	136	*	32	32	128	40	168	0.27
1995	.	.	.	.	*	.	.	.	.	.	.
1996	.	.	.	.	*	.	.	.	.	.	.
1997**		-	253	253	*	57	57	-	310	310	
1998**		-	131	131	*	89	89	-	220	220	
1999**		-	235	235	*	35	35	-	270	270	
84-89 $\bar{X}$	774.2	233.3	.	233.3	.	2.8	3.5	234.5	2.8	236.8	0.31
95% CL	185.9	78.4	.	78.4	.	3.2	3.0	80.3	3.2	81.0	0.10
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	816.5	216.7	.	216.7	.	13.0	2.7	216.7	16.3	219.3	0.27
95% CL	150.7	57.9	.	57.9	.	12.8	2.5	57.9	17.3	59.5	0.03
N	6	6	0	6	0	6	6	6	6	6	6
92-96 $\bar{X}$	653.0	170.7	6.7	177.3	.	23.0	23.0	170.7	29.7	200.3	0.31
95% CL	83.1	103.2	15.2	108.5	.	19.7	19.7	103.2	29.0	95.8	0.13
N	3	3	3	3	0	3	3	3	3	3	3

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1996 AND ON RETAINED FISH ONLY PRIOR TO 1985.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
**DATA OBTAINED FROM THE LICENSE STUB RETURN.
1995-1996 RIVER CLOSED TO ANGLING. 1997-1999 CATCH AND RELEASE ONLY.

APPENDIX 6. Biological characteristics of Atlantic salmon sampled on Barachois Brook, 29 August 1998

Size	No. (%)	Sex		Fork Length (cm)					Whole Weight (kg)					River Age					
		No.	% F	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	% 2*	% 3*	% 4*
Small Salmon	71(67.6)	70	54.3	71	51.9	5.5	41.5	62.5	71	1.4	0.5	0.7	2.5	64	3.0	0.3	3.1	89.1	7.8
Large Salmon	34(32.4)	34	94.1	34	67.0	3.8	63.0	78.0	34	2.9	0.6	2.3	4.7	29	2.9	0.3	10.3	89.7	0.0

Small Salmon

Sea Age	No. (%)	Sex		Fork Length (cm)					Whole Weight (g)				
		No.	% F	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
V1SW	49(70.0)	48	50	49	48.7	2.6	41.5	54.0	49	1.1	0.2	0.7	1.8
1SW.SM	13(18.6)	13	46	13	57.7	3.1	53.5	62.5	13	1.8	0.3	1.3	2.4
2SW	8 (11.4)	8	100	8	61.1	1.0	60.0	62.5	8	2.3	0.2	2.0	2.5
Unk		1	0	1	61.5	0.0	61.5	61.5	1	2.1	0.0	2.1	2.1

Large Salmon

Sea Age	No. (%)	Sex Ratio		Fork Length (cm)					Whole Weight (kg)				
		No.	% F	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
V1SW	1(3.0)	1	100	1	64.5	0.0	64.5	64.5	1	2.7	0.0	2.7	2.7
1SW.SM	5 (15.2)	5	80	5	66.7	3.2	63.2	70.5	5	2.8	0.6	2.3	3.5
1SW.SM.SM	2 (6.1)	2	50	2	72.5	2.8	70.5	74.5	2	3.5	0.8	2.9	4.0
1SW.SM.1	1 (3.0)	1	100	1	76.0	0.0	76.0	76.0	1	4.7	0.0	4.7	4.7
V2SW	22(66.7)	22	100	22	65.7	2.4	63.0	71.0	22	2.8	0.3	2.4	3.4
2SW.SM	1 (3.0)	1	100	1	69.0	0.0	69.0	69.0	1	3.1	0.0	3.1	3.1
2SW.SM.SM	1 (3.0)	1	100	1	78.0	0.0	78.0	78.0	1	4.3	0.0	4.3	4.3
Unk		1	100	1	64.0	0.0	64.0	64.0	1	2.6	0.0	2.6	2.6

By Sea Ages (All sizes combined)

Sea Age	No. (%)	Sex		Fork Length (cm)					Whole Weight (g)					River Age					
		No.	% F	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	% 2*	% 3*	% 4*
V1SW	50 (48.5	49	51.0	50	49.0	3.4	41.5	64.5	50	1.2	0.3	0.7	2.7	44	3.1	0.4	2.3	86.4	11.4
1SW.SM	18 (17.5)	18	55.6	18	60.2	5.1	53.5	70.5	18	2.1	0.6	1.3	3.5	18	2.9	0.2	6.0	94.0	0.0
1SW.SM.SM	2 (1.9)	2	50.0	2	72.5	2.8	70.5	74.5	2	3.5	0.8	2.9	4.0	1	2.0	0.0	100.0	0.0	0.0
1SW.SM.1	1 (1.0)	1	100.0	1	76.0	0.0	76.0	76.0	1	4.7	0.0	4.7	4.7	1	3.0	0.0	0.0	100.0	0.0
V2SW	30 (29.1)	30	100.0	30	64.6	2.9	60.0	71.0	30	2.6	0.3	2.0	3.1	28	2.9	0.3	7.1	92.9	0.0
2SW.SM	1 (1.0)	1	100.0	1	69.0	0.0	69.0	69.0	1	3.1	0.0	3.1	3.1	1	3.0	0.0	0.0	100.0	0.0
2SW.SM.SM	1 (1.0)	1	100.0	1	78.0	0.0	78.0	78.0	1	4.3	0.0	4.3	4.3	1	3.0	0.0	0.0	100.0	0.0
Unk		2	50.0	2	62.5	1.8	61.5	64.0	2	2.4	0.4	2.1	2.6	0	0.0	0.0	0.0	0.0	0.0

Appendix 7. Rationale for choosing the factors that were used to adjust the numbers of salmon counted in the snorkeling survey, 1999, to account for the salmon that were missed.

Crabbes River:

Section 1: Adjustment Factor - 1.10
The water in 2 of 21 pools was too deep to ensure that all salmon were counted. All other pools had relatively shallow water and sufficient snorkellers to survey entire pool. Salmon seem to be dispersed over a wide area.

Section 2: Adjustment Factor - 1.15
There was a complete coverage of all of Section 2 upstream of the gorge. Downstream of gorge there were 2 of 7 pools in which the snorkellers considered the count to be incomplete; however, they indicated relatively good coverage but, 2 more swimmers would give more confidence in the count.

Gorge: The number of salmon in the Gorge is assumed to be equivalent to 30% of the small salmon (adjusted) in Section 2. The proportion of the total number of salmon in the gorge that is in the large category is assumed to be the same as the proportion of large salmon upriver from the gorge (Section 1 + part of Section 2) at the time of the survey, which is 32/221 = 0.145. The gorge is about 1 km long and was partially surveyed. Two pools at the lower end of gorge were surveyed, but water was too deep to see the bottom in a portion of the pool. However only 4 small salmon were observed. If there were a large number of salmon more would have been seen since pools were relatively narrow and short. The uppermost pool in the gorge was also surveyed. The visibility was not good and only a partial count could be obtained. However, the pool was narrow and the velocity was high, the 8 salmon observed were in the lower end of the pool. The 2 snorkellers felt that there was not a large concentration of salmon in the pool or more would have been seen. The pool was surveyed several times and the salmon were repeatedly seen in the lower end of the pool where the visibility was reasonably good.

Section 3: Adjustment factor - 1.30
Two of 5 large pools needed two more snorkellers; although the crew leader felt that the coverage was complete in all but 1 pool.

Section 4: Adjustment factor - 1.20
There was complete coverage of 5 of the 6 pools. Only a partial count was obtained at a pool at the TCH bridge due the pool being too deep and wide; additional snorkellers were required. Since the pool at the TCH was the deepest and widest pool there may have been considerably more salmon than observed.

Section 5: The water level was to high to conduct a survey of this Section; however, four snorkellers floated down through the Section, but did not see any salmon. The numbers of small and large salmon in Section 5 were estimated by assuming that the proportion of the total river population that was in Section 5, in 1999, was the same as the average proportion estimated for

1996 and 1997. I.e. 0.045 of the total population of small salmon and 0.023 of the total population of large salmon.

Little Crabbes: River Guardians walked this tributary. No adjustment was made to their count.

Middle Barachois Brook:

Section 1: **Adjustment Factor - 1.05**
All pools had relatively shallow water and there were sufficient snorkellers to survey all pools. Snorkellers felt that there were complete counts in all pools.

Section 2: **Adjustment Factor - 1.20**
Incomplete counts were made in 4 of 17 pools. One of these pools (Sands Pool), in previous years, had contained a large number of salmon, and in 1999 one surveyor estimated over 50 salmon. The percentage of the average unadjusted numbers of large and small salmon in Section 1 and 2 (combined) that were counted in Sands Pool in 1996-97 was determined and applied to the count of small and large salmon in Section 1 and 2 in 1999. This provided an estimate of the numbers of small and large salmon in Sands Pool prior to adjustments. The calculated number of salmon in Sands Pool was added to the count in Section 2 before adjustment factor was applied. The adjustment of 20% was applied to Section 2 because of the number pools with incomplete counts.

Section 3: **Adjustment factor - 1.50**
One of 3 pools had incomplete count due to width and depth. Only a small number of salmon were counted in this Section, and most of salmon was counted in the pool with incomplete count.

Section 4: **Adjustment factor - 1.10**
Complete count was obtained in all 3 pools were salmon were seen.

Robinsons River:

Section 1: **Adjustment Factor - 1.25**
The large pool at the base of falls could not be surveyed. There were 2 out of 9 pools in which fish were seen but the count was considered partial. There were two large steadies where no fish were seen but there were insufficient snorkellers available to cover the entire width of the pool. Other pools were shallow and counts were considered complete.

Section 2: **Adjustment Factor - 1.10**
Complete counts made at all pools. Pools were all 2 m or less and bottom could be seen in all of them.

Section 3: Adjustment factor - 1.10
Salmon observed mostly in runs. There was only one pool in Section 3, which was at the confluence of Big Dribble Brook. Unlikely many salmon were missed.

Section 4: Adjustment factor - 1.20
Counts were considered incomplete in two pools because water was too deep to see bottom. There is normally a concentration of salmon in Cabin Pool, but in 1999 only one salmon was seen.

Northern Feeder: Lower section walked by River Guardians during the first week of September. No salmon were observed.

Fischells Brook:

Section 1: Adjustment Factor - 1.15
The water was too deep to get a complete count of salmon in two of 15 pools; however it was felt that few if any salmon were missed. Most concentrations of salmon were in shallow pools.

Section 2: Adjustment Factor - 1.10
Complete counts made in 11 of 12 pools. All pools, except 1 were 2 m or less and bottom could be seen in all of them. One pool was too deep to see bottom; therefore the count was incomplete. Some fish may have been missed in the steadies where occasionally the snorkellers had to stand up when assistants had difficulty keeping the rope in a straight line.

Section 3: Adjustment factor - 1.15
There were two of seven pools in which some salmon may have been missed due to width of pools. Surveyors felt most salmon counted in these pools.

Section 4: Adjustment factor – 1.10
One of four pools in this Section had a partial count because water was too deep to see bottom. However, snorkellers felt that it was unlikely that very many salmon were missed, only 3 fish were counted in this pool.

Flat Bay Brook:

Section 1 & 2: Adjustment Factor - 1.15
Survey crew was transported between pools by helicopter. Only pools in which salmon had been counted in previous years were surveyed in 1999. In past years very few salmon were seen between these pools. A partial count occurred in one of seven pools surveyed. Only one pool was too deep to be sure all salmon were counted.

Section 3: Adjustment Factor - 1.05
Short Section, and all pools had a complete count.

Section 4: Adjustment factor - 1.15
Twelve snorkellers were used. There was complete coverage of this Section; however there were 15 pools, many of which were very long. It was difficult for the surveyors to maintain visual attention for long periods. Thus some fish may have been missed.

Section 5: Water levels were too high to survey Section 5. The average percentage of the total estimated numbers of salmon in the entire river that was observed in Section 5 in 1996 and 1997 were used to calculate the number of small and large salmon. Calculations were as follows: in 1996 – 16% of the small salmon and 38% of the large salmon estimated for the entire river were in Section 5. In 1997 – 14 % of the small and 11% of the large salmon were in Section 5. Averages for both years are 16% of the small and 18% of the large salmon.